

TITLE OF THE INVENTION

**METHOD OF PROVIDING ANTIBACTERIAL ACTIVITY ON A
SURFACE OF A BODY USING NANO-SIZED METAL PARTICLES**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 2002-82682, filed December 23, 2002, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates, in general, to methods of providing antibacterial activity to a body using nano-sized metal particles and, more particularly, to a method of depositing nano-sized metal particles onto a body, characterized in that the nano-sized metal particles are dissolved in a volatile solution, to form a colloidal solution, which is coated onto a surface of the body, and then the coated body is thermally treated.

Description of the Related Art

[0003] As well known to those skilled in the art, home appliances requiring sanitation and cleanliness are exemplified by refrigerators, washing machines, vacuum cleaners, electric fans, drying machines, air conditioners, electric pots, rice cookers, dishwashing machines, dish drying machines, microwave ovens, mixers, VTRs, televisions, etc.

[0004] In general, with the aim of providing antibacterial activity to the above appliances, methods have been used of heating the appliances at high temperatures or of adding chemicals to the appliances.

[0005] However, when being heated, the appliances may be deformed and consequently are not heated at temperatures which are sufficiently high enough to exhibit antibacterial activity.

[0006] Additionally, when the appliances are treated with the chemicals, it is difficult to maintain an antibacterial effect. In particular, in case of cooking appliances, the used chemicals have a negative effect on food safety.

[0007] In order to solve the problems related to treatment of the appliances by heating or chemicals, Japanese Patent Laid-open Publication No. 2000-159898 discloses a method of fabricating a body having antibacterial activity for use in home appliances, by directly incorporating metal particles having antibacterial activity into a resin. The reason why the metal particles are used is that metal ions, in particular, silver (Ag) ions, function to kill all

bacteria while being harmless to the environment and to human beings . In other words, silver particles function to deactivate enzymes essential for metabolism of bacteria.

[0008] That is, the metal particles having antibacterial activity are incorporated into the resin, for example, polyolefin, and then melted together, to form the body having antibacterial activity suitable for use in home appliances, whereby a body requiring antibacterial activity has desired antibacterial activity. In addition, the formed body is not infected or discolored by bacteria or molds, and the value of the body as a commercial product is not decreased.

[0009] However, the above method is disadvantageous in that the metal particles are non-uniformly dispersed in the body or are contained in small amounts into the body, and thus antibacterial activity is not obtained at a desired level.

[0010] In order to have sufficient antibacterial activity, the body contains large amounts of the metal particles, and the metal particles should be exposed in abundance on the surface of the body. As such, however, antibacterial efficiency is relatively low in comparison with the amount of the used metal particles, and the formed body may be discolored due to the metal compounds incorporated into the resin. Accordingly, an external appearance of the body becomes inferior, and value thereof as a commercial product is decreased.

SUMMARY OF THE INVENTION

[0011] Accordingly, it is an aspect of the present invention to provide a method of providing antibacterial activity to a body by coating nano-sized antibacterial metal particles, capable of providing a large surface area of antibacterial function even though small amounts of the metal particles are used, onto a surface of the body for use in home appliances.

[0012] Additional aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0013] The foregoing and/or other aspects of the present invention are achieved by providing a method of providing antibacterial activity to a surface of a body by use of nano-sized metal particles, including coating a volatile solution dispersed with nano-sized metal particles onto the surface of the body, and thermally treating the coated body, whereby the nano-sized metal particles having antibacterial activity are deposited onto the body.

[0014] The method further includes drying the coated body before thermally treating the body coated with the nano-sized metal particles.

[0015] In addition, it is preferred that the thermal treatment operation is performed at 50-150°C to prevent deformation of the body.

[0016] More preferably, the thermal treatment operation is performed at 150°C.

[0017] The nano-sized metal particles used for the coating operation are used in an amount of 100-2000 ppm, based on the volatile solution.

[0018] In an aspect of the invention, the nano-sized metal particles used for the coating operation are used in the amount of 1000 ppm, based on the volatile solution.

[0019] The nano-sized metal particles have a sterilizing function.

[0020] Particularly, the metal particles having the sterilizing function are any one selected from the group consisting of silver (Ag), aluminum (Al), copper (Cu), iron (Fe), zinc (Zn), cadmium (Cd), palladium (Pd), rhodium (Rh) and chrome (Cr).

[0021] Also, the body is suitable for use in home appliances, such as refrigerators, washing machines, and air conditioners.

[0022] In particular, the body is a filter for air cleaners.

[0023] Further, refrigerators, washing machines, and air conditioners including the body fabricated by the method of the present invention are provided.

BRIEF DESCRIPTION OF THE DRAWING

[0024] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawing of which:

[0025] FIG. 1 is a flow chart illustrating a process of providing antibacterial activity to a surface of a body by use of nano-sized metal particles according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Reference will now made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0027]

[0028] FIG. 1 is a flow chart illustrating a process of providing antibacterial activity to a surface of a body using nano-sized metal particles according to the present invention. As shown in FIG. 1, the method of the present invention includes dispersing nano-sized metal particles into a solution in operation 100, coating the solution dispersed with the nano-sized metal particles onto the body in operation 110, drying the coated body in operation 120, and thermally treating the coated or dried body in operation 130.

[0029] <Dispersing Nano-Sized Metal Particles Into A Solution In Operation 100>

[0030] In operation 100, nano-sized metal particles are added into a dispersing medium and dispersed therein. The dispersing medium is exemplified by a volatile solution, such as water or ethanol.

[0031] The nano-sized metal particles have an average particle size of 500 nm or smaller, preferably 300 nm or smaller, and more preferably 3-250 nm.

[0032] The nano-sized metal particles of the present invention, which have antibacterial activity, are selected from the group consisting of silver (Ag), aluminum (Al), copper (Cu), iron (Fe), zinc (Zn), cadmium (Cd), palladium (Pd), rhodium (Rh) and chrome (Cr). The metal particles may be used alone or as alloys thereof. In particular, silver (Ag) ions are known to function to kill all bacteria while being innocuous to the environment and human beings. Thus, as the nano-sized metal particles, silver (Ag) is preferably used.

[0033] Meanwhile, the nano-sized metal particles of the present invention may be blended with non-metal particles. However, in such a case, antibacterial activity is decreased. In Table 1, there are shown the results of Halo test measuring antibacterial activities of only silver (Ag) particles and a mixture of silver (Ag) and sulfur (S) particles using *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 6538 strains.

[0034] *Escherichia coli* ATCC 25922, which is low in heat resistance, is sterilized when being heated at 60°C for about 20 min. *Escherichia coli* is a bacillus having both round-shaped ends with a length of 2-4 μm and a width of 0.4-0.7 μm , and is motile due to the presence of flagella. Also, *Escherichia coli* does not make spores and is a gram-negative bacterium. *Staphylococcus aureus* ATCC 6538 strains, belonging to the family *Micrococcaceae*, are gram-positive facultative anaerobic cocci (0.8-1.0 μm across) which form small spherical cells often arranged in irregular clusters when being observed by a microscope, and are classified into 23 species 4 subspecies. In particular, *Staphylococcus*

aureus is an important bacterium causing various infections including food poisoning, and other bacteria of the family *Micrococcaceae* are opportunistic infection bacteria.

TABLE 1

Test Strain	Amount (ppm)	Coated Body	Halo (mm)	
			Ag	Ag + S
<i>Escherichia coli</i> ATCC 25922	100	Copper	1.0	0.0
		Stainless	0.0	0.0
	500	Copper	1.0	1.0
		Stainless	1.5	0.5
<i>Staphylococcus aureus</i> ATCC 6538	100	Copper	1.5	1.5
		Stainless	0.0	0.0
	500	Copper	3.5	1.0
		Stainless	1.0	0.5

[0035] In addition, the nano-sized metal particles are used in the amount of 100-2000 ppm, based on the volatile solution. If the amount of the metal particles is smaller than 100 ppm, water is used in relatively large amounts, and thus a period of time required to remove the water becomes long. Further, antibacterial activity is not sufficiently exhibited. On the other hand, if the amount exceeds 2000 ppm, antibacterial activity is not drastically decreased but

the metal particles are not uniformly deposited onto the surface of the body. Also, the surface of the body may be discolored and cost required to prepare the body having antibacterial activity may increase. Table 2, below, shows the results of a Halo test according to the amounts of the used strains.

TABLE 2

Test Strain	Amount (ppm)	Halo (mm)
<i>Escherichia coli</i> ATCC 25922	100	1.5
	500	1.5
	1000	1.5
	1500	1.5
	2000	1.5
<i>Staphylococcus aureus</i> ATCC 6538	100	2.0
	500	2.0
	1000	2.5
	1500	2.5
	2000	2.5

[0036] The body having antibacterial activity according to the method of the present invention is suitable for use in various home appliances requiring antibacterial activity, which are exemplified by refrigerators, washing machines, vacuum cleaners, electric pans, drying machines, air conditioners, electric pots, rice cookers, dishwashing machines, dish drying machines, microwave ovens, mixers, VTRs, televisions, etc.

[0037] Coating Nano-Sized Metal Particles Dispersed Solution Onto A Body In Operation 110

[0038] In operation 110, a colloidal solution formed by dispersing the nano-sized metal particles into the volatile solution is sprayed onto the surface of the body, or the body is immersed in the colloidal solution.

[0039] Drying The Coated Body In Operation 120

[0040] In operation 120, the coated body is naturally dried to shorten a period of time required to perform the next thermal treatment operation or to efficiently perform the thermal treatment operation. The drying operation may be omitted to immediately heat the coated body.

[0041] Thermally Treating The Coated or Dried Body In Operation 130

[0042] In operation 130, the body which is coated with the nano-sized metal particles dispersed solution in operation 110, or dried in operation 120, is thermally treated in an oven. Through the thermal treatment, the nano-sized metal particles are deposited onto the body.

[0043] However, when the body is thermally treated at too high a temperature, the surface of the body is deformed and an external appearance thereof may be degraded. Thus, it is preferable that the thermal treatment operation is performed at 50-150°C to prevent deformation of the body. Table 3, later herein, shows the Halo according to the amounts of the used strains and thermal treatment temperatures.

[0044] In the thermal treatment operation, high oven temperature results in increasing electricity costs as well as treatment cost for heat resistance. When being subjected to a nano-coating process at 150°C or higher, a body or a filter is thermally deformed and thus may be damaged.

[0045] In addition, as the method of depositing the nano-sized metal particles to the body, there is an ion-adsorption reduction method, in which only the silver component is selectively attached onto a desired body by use of electrolysis of silver solution. However, the ion-adsorption reduction method suffers from disadvantages in terms of non-uniform coated surface thickness, high electricity costs, and an additional water treatment. Thus, the thermal treatment method is preferable in view of stability of the body or economic benefits of the operations.

TABLE 3

Test Strain	Amount (ppm)	Halo (mm)	
		Heating at 100°C	Heating at 15°C
<i>Escherichia coli</i> ATCC 25922	50	0.0	0.0
	100	0.0	0.0
	150	2.0	2.0
<i>Staphylococcus aureus</i> ATCC 6538	50	0.0	0.0
	100	0.0	0.0
	150	1.0	2.0

[0046] As described above, the method of providing antibacterial activity to the body by use of the nano-sized metal particles according to the present invention, is advantageous in that the metal particles are not embedded into the body but are deposited on the surface of the body, thus increasing a sterilizing performance. Further, antibacterial activity of the body for use in home appliances is sufficiently exhibited even though small amounts of the nano-sized metal particles are used.

[0047] In addition, the method of the present invention is favorable in terms of no degradation of the external appearance of the body due to use of the volatile solution.

[0048] Further, the thermal treatment operation is performed at 50-150°C, whereby the body is not deformed, thus resulting in economic benefits .

[0049] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.